**Unit 2 (Biochemistry) Calculations Practice and Review**

**Part A: Q10 Metabolism Calculations**

1. The rate of metabolism of a certain animal at 10ºC, is 27 lO2 g-1h-1.

What are its rates of metabolism at 20, 30, and 40 ºC if the Q10 is 2? If it is 2.5?

**((*T*2*T*1)/10))**

*R*2 *R*1 x *Q*10

|  |  |
| --- | --- |
| **Temperature** ºC | **Rate2 if Q10 = 2** |
| 20 |  |
| 30 |  |
| 40 |  |

|  |  |
| --- | --- |
| **Temperature** ºC | **Rate2 if Q10 = 2.5** |
| 20 |  |
| 30 |  |
| 40 |  |



Graph showing the effect of Temp on Rx rate

2. The following table reports the rates of metabolism of a species at a series of ambient temperatures:

|  |  |
| --- | --- |
| Temperature (ºC) | Rate of Metabolism (lO2 g-1h-1.) |
| 15 | 10 |
| 20 | 13.42 |
| 30 | 21.22 |

(a) Calculate the Q10 values for each temperature interval.

**(10/(*T*2*T*1))**

*Q*10 {*R*2/*R*1}

(b) Within which temperature interval (15-20 or 20-30) is the rate of metabolism most sensitive to temperature change?

(c) For this species, would a Q10 calculated for 15 to 30 ºC be as useful as several for smaller temperature ranges? Calculate that Q10 as part of your answer.

3. The reaction rate for a certain process at **14** ºC **is 15 units / time.**

(a) What would be the reaction rate at 20 ºC if the Q10 = 1?

**Part B: Gibbs Free Energy Calculations**

**ΔG = ΔH - T ΔS**

What is Entropy? = a measurement of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

When **Δ**S is positive this means there is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

When **Δ**S is negative this means there is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is **Δ**H? = a measurement of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

When **Δ**H is positive this means the reaction is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

When **Δ**H is negative this means the reaction is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What is Gibbs Free energy? = a measurement of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

When **Δ**G is positive this means the reaction will happen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

When **Δ**G is negative this means the reaction will happen \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
| ΔG (Joules) | ΔH (Joules) | T (Kelvin) | ΔS (J/K) |
|  | 1000 | 300 | 5 |
|  | 1100 | 300 | 5 |
|  | 1200 | 300 | 5 |

What happens to ΔGwhen ΔH goes up ? WHY?

What happens to ΔGwhen ΔH goes down ? WHY?

|  |  |  |  |
| --- | --- | --- | --- |
| ΔG | ΔH | T | ΔS |
|  | 1700 | 300 | 5 |
|  | 1700 | 310 | 5 |
|  | 1700 | 320 | 5 |

What happens to ΔGwhen T goes up ? WHY?

What happens to ΔGwhen T goes down ? WHY?

|  |  |  |  |
| --- | --- | --- | --- |
| ΔG | ΔH | T | ΔS |
|  | 7500 | 300 | 5 |
|  | 7500 | 300 | 10 |
|  | 7500 | 300 | 15 |

What happens to ΔGwhen ΔS goes up ? WHY?

What happens to ΔGwhen ΔS goes down ? WHY?

Biochemical free energies are usually given as standard free energies of hydrolysis. For example, the hydrolysis of glucose-6-phosphate:

|  |  |  |  |
| --- | --- | --- | --- |
| |  | | --- | |  | | 24635 | |  | |

has ΔG° = -4.0 kcal/mole (-16.5 kJ/mole) under standard conditions. Therefore, the opposite reaction, the phosphorylation of glucose, is unfavored. However, the phosphorylation of glucose occurs readily in the cell, catalyzed by the enzyme hexokinase:

|  |  |  |  |
| --- | --- | --- | --- |
| |  | | --- | |  | | 24636 | |  | |

The other half of the phosphorylation reaction is the hydrolysis of ATP to yield ADP and inorganic phosphate (Pi):

|  |  |  |  |
| --- | --- | --- | --- |
| |  | | --- | |  | | 24637 | |  | |

under standard conditions has ΔG° = -7.3 kcal/mole (-31 kJ/mole).

The standard free energy change of the reaction can be determined by adding the two free energies of reaction:

|  |  |  |  |
| --- | --- | --- | --- |
| |  | | --- | |  | | 24638 | |  | |

Note that the reaction as written is unfavored; its free energy change is positive. Another way of stating this is that the reaction is **endergonic,** that is, the reaction involves a gain of free energy.

For the **exergonic** hydrolysis of ATP (the reaction involves a loss of free energy):

|  |  |  |  |
| --- | --- | --- | --- |
| |  | | --- | |  | | 24639 | |  | |

The two reactions are summed:

|  |  |  |  |
| --- | --- | --- | --- |
| |  | | --- | |  | | 24640 | |  | |

This is a simple example of energetic **coupling,** where an unfavorable reaction is driven by a favorable one, as shown in Figure [1](http://www.cliffsnotes.com/study_guide/FreeEnergy-Calculations.topicArticleId-24998,articleId-24948.html#schmidt5630c03-fig-0001) .

|  |
| --- |
|  |
| |  | | --- | |  | | 24644 | |  | |

Coupling doesn't occur all by itself. In this example, if this experiment were set up so that the ATP would have to be hydrolyzed in one tube and the glucose phosphorylated in another, no coupling would be possible. Coupling can occur only when the partial reactions are part of a larger system. In this example, coupling occurs because both partial reactions are carried out by the enzyme hexokinase. In other cases, coupling can involve membrane transport, transfer of electrons by a common intermediate, or other processes. Another way of stating this principle is that coupled reactions must have some component in common.

The “orderliness” of your body is not favored by free energy. Explain (in terms of free energy and disorder) why you need to perform digestion?

Why does decomposition of a dead animal happen in terms of energy? What would happen if we increase temperature? Why do we freeze food?